FRANKLIN ELECTRONICS INCORPORATED
COMMUNICATIONS & CONTROL DIVISION

MODEL 201 DIGITAL VOLTMETER

S/N_____

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DATA SHEET

COMMUNICATIONS and CONTROL
A DIVISION OF FRANKLIN ELECTRONICS INC.

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DATA SHEET

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INTRODUCTION:

The 201 Digital Voltmeter is a low price analog-digital converter. It has been designed for:

a. Bench use and/or rack use.

b. Medium accuracy absolute.

c. High accuracy between comparative readings.

d. The measurement of d.c. and a.c. voltages.

It makes available, for the first time, a reliable low priced digital voltmeter which gives the advantages of digital readout without the cumbersome unstable, complex circuitry of more expensive devices which do the same work.

It is an optimal design using transistors wherever any advantages accrue therefrom and vacuum tubes. The readout, determined after customer preference tests, is an easy to read vertical column of numbers. These can be read over a relatively wide angle in any direction.

The 201 Digital Voltmeter has been designed to provide high input impedance, medium absolute accuracy, high comparative accuracy between successive readings, and good reliability.

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SPECIFICATIONS:

Franklin Electronics Model 201 Digital Voltmeter
1, 10, 100, 1000 volts A.C. - D.C.

RANGE:	Manually Set Automatic indication.
POLARITY:	Manually Set Automatic indication.
INPUT IMPEDANCE:	Over 9 megohms on all ranges except, 2 megohms on 10 volt range, and 1 megohm on the 1 volt range.
ACCURACY:	D.C. Better than 1% of full scale all ranges. A.C. Better than 2% above 4% of full scale on all ranges 50 cps to .6 megacycles.
CALIBRATION:	Internal mercury cell.
COMPONENTS:	Seven (7) tubes, seven (7) transistors, three (3) cold cathode counting tubes.
SIZE:	Rack mount 7" x 19", x 8¼" deep. Portable 6½" high 8½" wide 8¼" deep.
WEIGHT:	Eleven (11) pounds.
POWER SUPPLY:	115v ± 10% 50-60 cps 58 watts.
WARM UP TIME:	Fifteen (15) minutes.

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BASIC OPERATION:

The 201 Franklin Digital Voltmeter converts d.c. voltages into digital numbers. If an a.c. voltage is to be converted, it is first turned into a d.c. voltage by a suitable rectifying circuit and the conversion is then made on the d.c. voltage applied.

The method of conversion is novel. Refer to Figure I. By a special patentable circuit a linear staircase is developed. Each tread on this staircase represents an increment of one millivolt. Thus, the first tread is one (1) millivolt, the hundredth tread is 100 millivolts. There are a thousand complete treads in the staircase. Thus, 1 volt represents full scale and is the top of the staircase. This staircase is generated with high linearity through a patentable circuit which makes use of transistors. Basically, a capacitor is charged with equal quantities of electrical charge. However, by an ingenuous feedback circuit, the previous charge on the capacitor does not work against the succeeding quantity of electricity being put into the capacitor. Thus each pulse adds this fixed quantity to the capacitor. Since the voltage across a capacitor is equal to the product of the capacitance and the charge on it, equal charge means equal increments of voltage. These treads on the staircase are generated at a 4 kc rate. Thus, the top of the staircase can be reached in one-fourth of a second. The display time is set at the factory at about one (1) conversion per second. This is for convenience of reading. The same pulse which generates the fixed quantity of electricity being entered into the capacitor is logged on a gas filled counting tube. This tube counts at rates up to 4 kc and is therefore the limiting factor on the conversion speed. Thus when the one hundredth tread is being generated, the counter has received 100 counts representing 100 quantities of electricity and the count would be 100. On the 532nd tread the count would be 532. Translated into voltages, since each tread represents 1 millivolt, the tread and the count also represents volts with 1.000 volts representing full scale.

In addition to generating quantities of electricity and logging the count representing the number of quantities of electricity, at each tread a comparison is made. The input analog voltage to be converted is compared with the voltage on the tread. So long as the tread voltage is less than the analog voltage, the count is logged. However, when the comparison indicates that the tread voltage is equal to the analog voltage being converted, the counter counts are no longer logged. Therefore, the count that remains on the counter represents the analog voltage being converted.

All conversions are made at a 1.000 volt full scale reading. Higher voltages are manually attenuated to 1.000 volts with the manual range switch on the front of the instrument. Similarly,

voltages are rectified and attenuated (if necessary) and again the conversion is made on a d.c. voltage of 1.000 volts full scale.

In summary, then, the fundamental operation is as follows:

1. An analog voltage is inserted in the front of the instrument.
2. The mode, a.c. or d.c., is selected.
3. The range is selected.
4. The polarity is selected in the event the voltage is d.c.
5. The internal staircase which is generated is compared continuously by the instrument with the input analog voltage.
6. When the staircase voltage is equal to the analog voltage, the count is stopped.
7. This, then, represents an analog voltage in digital form.

To perform these operations, the instrument has been designed utilizing transistors and vacuum tubes. As previously mentioned, the staircase is generated with a patentable transistor circuit which provides for equal charge entering the capacitor, irrespective of the charge already standing on the capacitor. The count is logged in cold cathode gas ring tubes. This is to increase reliability. For convenience of reading, the various digits on the (10,000 hours) NE-2E indicator bulbs. These indicator bulbs are covered by a plate showing the numerical value of that light. Power for the whole unit is supplied from long-life silicon rectifiers. The comparisons between the input analog voltage and the tread voltage is made with an ingenuous and patentable error amplifier. This is basically a phase sensitive device.

A calibration feature is included - switching the range switch to the calibrate position disconnects the regular input and applies a mercury cell and resistor divider. This makes it possible to check the operation and accuracy of the instrument without disconnecting the input. The divider drops the battery voltage of 1.34V to 1.000V.

ORGANIZATION OF THE INSTRUMENT:

The entire instrument is constructed on printed circuitry. All points are hand soldered, no dip soldering is used anywhere on the instrument. Fundamentally, four boards are used.

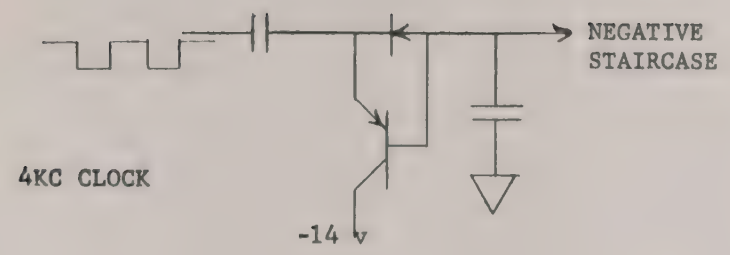
1. Indicator light board mounted on the front panel which is an assembly of NE-2E bulbs and associated resistors to provide a visual indication for reading.

2. A rectifier board with transformer to provide the necessary d.c. voltages and line isolation.

3. A logic counting board which incorporates three gas filled cold cathode counting tubes and associated circuitry.

4. A capacitor charging board and associated error amplifier for generating tread voltages and comparing them with the input analog voltage.

This basic organization of a few parts allows interchanging of parts for simple maintenance. Complete boards may be substituted in the event of difficulty while the questionable board is examined in detail for malfunctions.



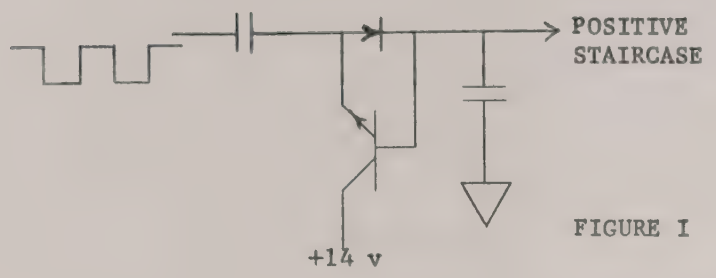


FIGURE I

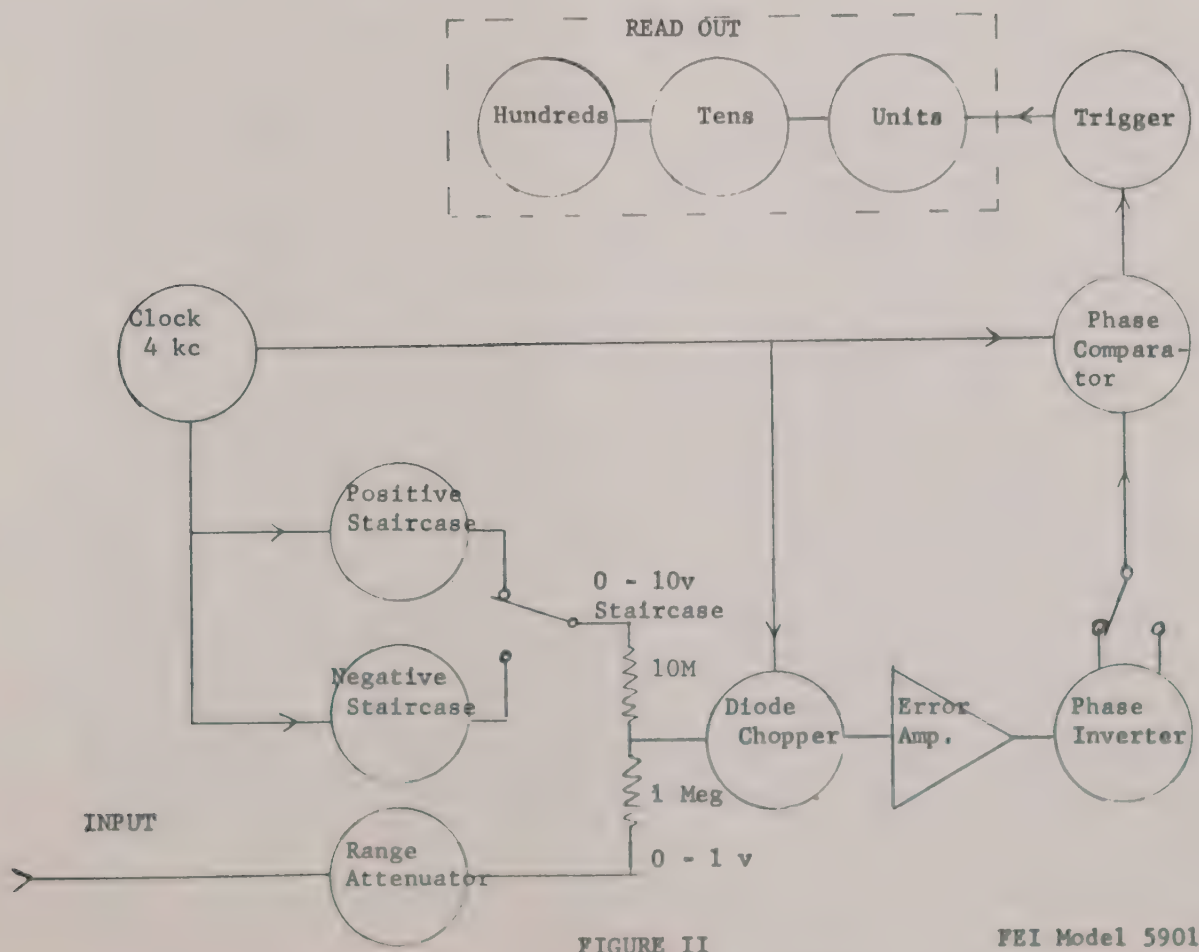


FIGURE II

THEORY OF OPERATION

A. Clock

The clock, V6, is a Wien bridge oscillator operating at 4 kc, used because of its frequency stability. The clock is used to drive the stairstep circuit, the diode chopper and the phase comparator. Before the clock waveshape can be used, it has to be squared up. The amplitude of the sine wave is great enough, 120V peak to peak, so that all that is necessary is that it be clipped to 20 volt peak to peak. This is done with a voltage divider, R131, R132 and N32, and two germanium diodes, D5, D6. The output of the clipper is fed through a cathode follower, V7B, for isolation. This 20 volt square wave is sufficient to drive the comparator, but the staircase generator and the chopper need a more stable amplitude. The mercury battery, B1, provides this very stable voltage. The square wave is again clipped, this time down to the 4 volt of the mercury battery, with D9 and D10 diodes.

B. Staircase Generators

The staircase generator is a circuit which makes it possible to charge up a capacitor in steps of equal voltage. There are two of these staircase generators: One is for a positive going staircase, the other is for a negative going staircase. These generators generate over one thousand steps of equal amplitude, each step being ten millivolts. The operation for a negative going staircase is as follows: The four volt square wave is fed through C34 and C35 to T5 and D13. C34 + C35 is very small compared to C38. During the negative cycle, the complete negative charge on C34 + C35 charges into C38, because of the forward conduction of the diode D13. The T5 transistor emitter to base diode is back biased; therefore, the transistor is cut off. During the positive cycle, the positive wave cannot go through the diode, but it does drive the emitter of the transistor so that the emitter to base diode of the transistor is forward biased. As long as this condition exists, the transistor has gain and collector current flows until the emitter voltage equals the base voltage. Thus, after each charge is put into C38, Point B is boosted to this level by the transistor action, and each successive charge is of equal amplitude. The operation of the positive staircase is the same, however the polarity of the diode is reversed and an NPN transistor is used. The diodes of these circuits are germanium because of their very low forward resistance. The transistors are silicon because of their extremely low Ico and Ieo. C34 is the calibrate adjustment. This is common for both ramps. Adjustment of C34 changes the amount of charge that is fed into C38. C32 and C33 are auxillary calibration adjustments which provide a means to compensate for the differences in the beta's of the transistors T5 and T6.

C. Chopper

The staircase voltage is added to the input voltage of the opposite polarity, R156 and R157. The sum of these two voltages is chopped to ground with a silicon diode bridge chopper, D15 and D16. Silicon diodes are used because of their extremely high back resistance. This chopper is driven by the clock, which is a symmetrical square wave. During one half of the period of the clock, the diodes of the chopper will be back biased. This will allow the summing junction of R156 and R157 to go where it will, depending on the two applied voltages. During the next half cycle, the diodes will conduct, thus shorting the summing junction to ground. This action will bring about a square wave at the summing junction that will change in phase as the staircase voltage passes the voltage that is equal and opposite to the input voltage. R172 is the zero adjustment. It makes up for any diode differneces. As this is a square wave of changing phase and contains no D.C. component, it is only necessary to amplify this wave in a simple A.C. amplifier.

D. Error Amplifier

The first tube of the error amplifier V9 is cathode biased. There is a bleeder resistor, R170, from B+ which draws current through the cathode resistor R169. This pulls the cathode potential to 1.8 volts. By doing this, it is unnecessary to use a grid coupling capacitor. A coupling capacitor at this point would cause the grid to block on large pulses. The grid being high impendance once blocked, would require a very long time to recover. The first tube, because of the impedances, integrates the wave form so this is fed into the second stage with a small coupling capacitor C47 and into two diodes, D11 and D12, which differentiate the waveform back into a square wave. The second tube V8 is a conventional cathode biased amplifier. Both of these tubes use NE-2E gas tubes as screen voltage regulators.

E. Phase Comparator

After amplification, the amplitude is clipped to 20 volts with D7 and D8 and the Divider consisting of R159, R160, R161, and N42. The clock and amplified error signal now are the same amplitude and can be resistively "anded" with R133 and R143. When two square waves are "anded" in phase, there will be an output. The error signal will be in phase with the clock as long as the staircase is less than the input voltage. When the staircase is greater than input voltage, the wave forms will be out of phase and there will be no output. The output of this phase comparing circuit is not capable of driving the counters. Thus it is necessary to feed this into a trigger circuit which will provide a sufficient pulse to drive the cold cathode counters.

F. Trigger

The trigger shapes up the output of the comparator so that it is suitable to drive the cold cathode counters. This trigger is a conventional transistorized one shot trigger circuit consisting of T2, T3, and T4. Included in the trigger is a control which inhibits the trigger for the duration of the reset pulse. This control is composed of dividers R111, R112, R114, and D4. When the reset pulse goes negative, it draws base current in T2, holding it in its normally saturated state. The diode D14 prevents the junction of R111, and R112, from going positive when the reset plate goes positive. When the reset plate does go positive, T2 is biased normally and the one shot can operate. T1 is used for polarity reversal and buffering.

G. Counter Tubes

The positive pulse out of the trigger is fed into the cold cathode tube driver V1b. Here it is amplified and inverted. This is then fed to the guides of the first counter tube V2. The waveform is directly applied to guide 1 through a capacitor C6. The wave form going to guide 2 is passed through a resistor R19 first, and the guide has a capacitor C7 to ground. The purpose of this is to delay the pulse by a minimum of 10u. Sec. Proper timing of the ignition and extinction of adjacent guides is the key to reliable operation. Four steps must occur in order: Ignition of guide 1, ignition of guide 2, extinction of guide 1, and extinction of guide 2. This is shown in waveforms, figure 3. The drivers for the other counter decades are identical in operation to the first. There is a ten line electrical output available on the back of the indicator board. Each of these resistors is in series with the lamps on the opposite side of the board. The common side of the resistors is biased to -300V. When a lamp ionizes, it draws current through its resistor and developes a voltage drop of 20V. So the lines that are on will drop to -280V.

H. Reset Generator

The reset generator resets the counter tubes to zero, discharges the staircase capacitor to ground, inhibits the trigger, and determines the display time. The reset generator consists of a simple neon tube relaxation oscillator and a tube. The tube, V1a, is normally in a cut-off condition. When the neon tube, N1, ionizes, the grid of the tube will draw current. The tube will then saturate as long as the neon tube is ionized. The plate waveform will thus be a large amplitude negative pulse, approximately 300V with a 3m Sec. duration. By changing the values of R2 and R3, the display time can be varied. Decreasing of R2 will decrease the display time, decreasing of R3 will increase it. Resetting of the counters is accomplished by driving 900, 90 and 0 cathodes of the counters more than 100V negative with respect to the other cathodes. This is done with D1, D2, and D3. The

common side of these diodes is biased to a point approximately 40V positive with respect to the cathodes. When the reset pulse comes along, it passes through C3 and drives the three diodes into conduction and, therefore, drives the cathodes negative, causing these cathodes to ionize, and the count will be 990. On the positive return of the reset pulse of the zero cathode, a pulse is passed forward indexing the 990 count to 000. The discharging of C38, which is the staircase capacitor, is done by saturating T7. T7 is a silicon transistor which is normally in the cutoff state, with the base returned to the emitter through R155. The junction of R152, R153 and R154 is normally close to ground potential, well below the ionization voltage of N39. When the reset pulse comes along, this junction goes far enough negative so the NE-2E ionize, causing T7 to saturate. When saturated, the transistor will conduct away all of the charge that has built up in C38 and leave only about 50 millivolts. On the passing of the reset pulse, the voltage at the junction of R152, R153, and R154 will return to its near ground potential. The NE-2 will deionize and T7 will return to the cutoff condition and the charges can again build up in the capacitor C38. The operation of this transistor is the same for either polarity of staircase.

I. A. C. Converter

When the instrument is switched to the A.C. mode, an amplifier and rectifier circuit is switched in after the input attenuator. The attenuator is such that a full scale of any range it will always put one volt into a one megohm load. In the D.C. mode this one megohm resistor is R157, and in the A.C. mode it is the grid resistor R182 of V10. V10 is an amplifier that is stabilized with the unbypassed cathode resistor. This stage has a gain of approximately ten. It is followed by a cathode follower which is the second half of V10. The output of the cathode follower is approximately 10 volt RMS. This means approximately 28V P. P. The rectified output will therefore be 0-28V D.C., so it is necessary to divide this down to the one volt level with R176, R175 and R174. R174 being the calibration adjustment for low frequency on the one volt range. C53 is a positive feedback path that increases the gain for high frequencies. It is adjusted on the one volt range at 600 kc. The trimmer capacitors mounted under the range attenuator switch are used to trim up the high frequency response of each range: C55 for the 10 volt range, and C57 for the 1000 volt range.

J. Output

Electrical outputs are available internally. These are in a ten-line code. On the back of the readout board are thirty resistors. Each of these resistors is associated with the neon lamp that is directly through the board from it. One side of each of these resistors is tied to a common point. This point is approximately

-300V. When the neon lamps ionize, the current (200 ua) is drawn through the associated resistor, thus developing 20 volts across it. Connections may be made to these resistors and the leads brought out to drive a ten line printer.

K. Power Supply

The power supply is a resistance capacitance filter fed by silicon rectifiers. All critical circuits are protected from voltage fluctuations by NE-2E lamps. Therefore, it is not necessary to have a regulated power supply. The power for the transistor circuits is taken from the high voltage supplies dropped through a divider, then limited to the NE-2E conduction voltage (approximately 65V.), and finally dropped to a suitable voltage for the transistors.

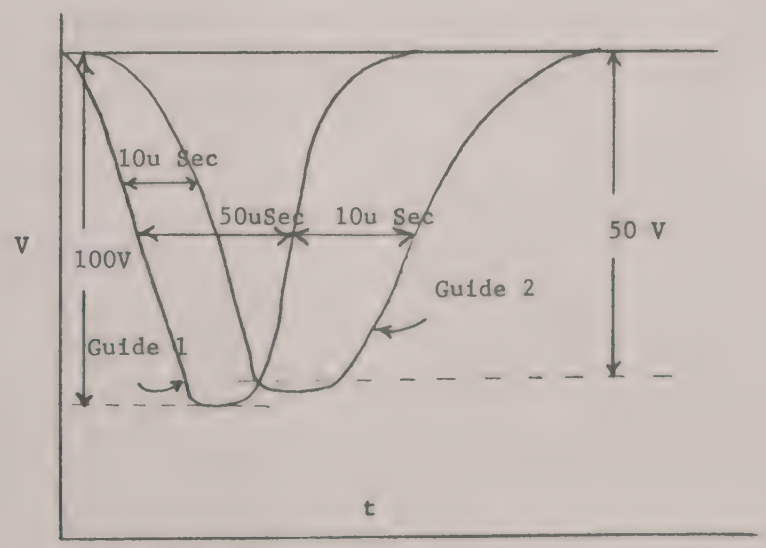


Figure 3

Minimum requirements for proper operation of counter tubes.

CALIBRATION PROCEDURE

A. Zero Set

After warm-up (about 15 minutes) set range switch on the 1 volt range and short the input leads together. Switch polarity selector to + input and note reading on the display. Then switch to negative input position and again note reading. These readings should be 000. If one or the other reading is above 000, an adjustment of R172 will be necessary. Changing the setting of R172 will affect both polarities, so it is necessary to switch back and forth between both polarities while adjusting R172. R172 is located on the front panel.

B. Calibrate Set

After the zero has been set as above, switch range switch to Cal position. Check the reading obtained on both polarities, these readings should be (1) 000. Normally, all that is necessary to bring both polarities into calibration is the adjustment of C-34 through the access hole in the front panel. If both polarities don't calibrate to the correct count, there are auxillary adjustments for each polarity, C-32 for positive, C-33 for negative.

If it is found that C-32 or C-33 does not have sufficient range, a readjustment of C-34 will be necessary for that polarity. Then switch polarity and use the other auxillary adjustment to bring the other polarity into calibration.

C. A. C. Calibration

To calibrate the A. C. circuits, it is first necessary to set the zero and calibrate the D.C. polarities. After this is done, switch the mode selector to A.C. and the range switch to the one volt range. Put in an accurace one volt RMS sine wave of a frequency of 400 cycles. Adjust R174 for a count of (1) 000. Now increase the frequency to 600 Kc, the amplitude still being 1 volt. Adjust C53 for a count of (1) 000. These two adjustments are located on the power supply board next to the power transformer. They are accessable through the back of the instrument. The variable capacitors in the attenuator are all adjusted at 600 Kc with a voltage preferably full scale of each range, C55 for 10V range, C56 for 100V range, and C57 on the 1000 volt range.

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ELECTRICAL SCHEMATIC
DIGITAL VOLTMETER
MODEL 251

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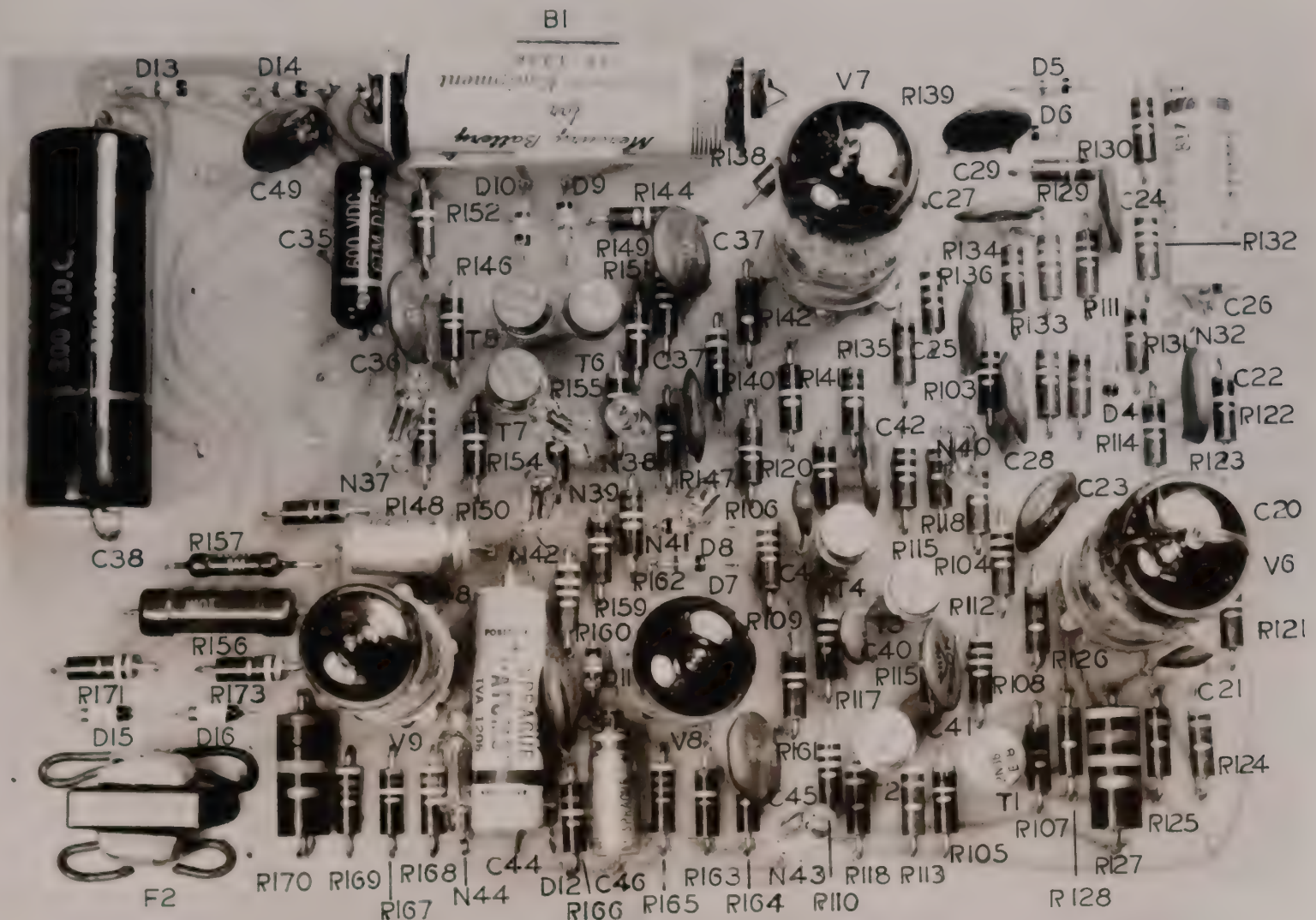
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D14
C49
C35
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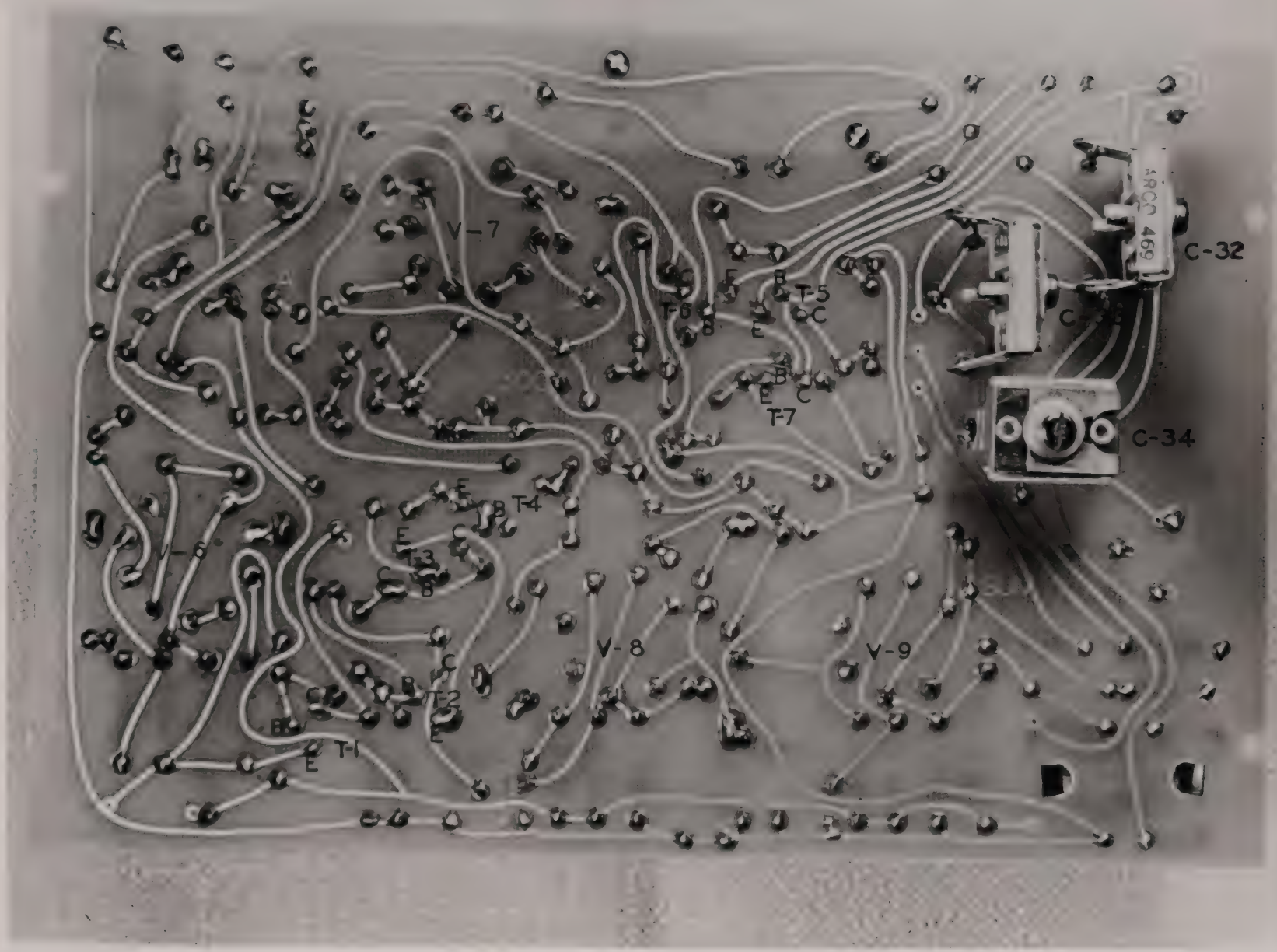
D10
D9
R144
R152
R149
R151
R146
C37
V7
R139
D5
D6
R138
C29
R130
C27
R129
C24
R132
R134
R136
R133
R111
C26
C36
T8
T6
C37
R142
R135
C25
R131
N32
R155
R140
R141
R103
C22
T7
R154
C42
N40
C28
D4
R114
R122
R123
N37
R148
R150
N38
R147
R120
N39
R106
C23
C20
R157
C38
N42
N41
D8
R118
R115
R104
V6
R162
D7
C4
T4
R159
R160
R109
R112
R121
R156
R171
R173
C40
R115
R108
R126
C21
R117
D15
D16
V9
V8
R161
C41
R124
C45
T2
T1
R107
R125
R105
R127
C44
D12
C46
R163
N43
R118
R113
R170
R169
R168
R167
N44
R166
R165
R164
R110
R128
F2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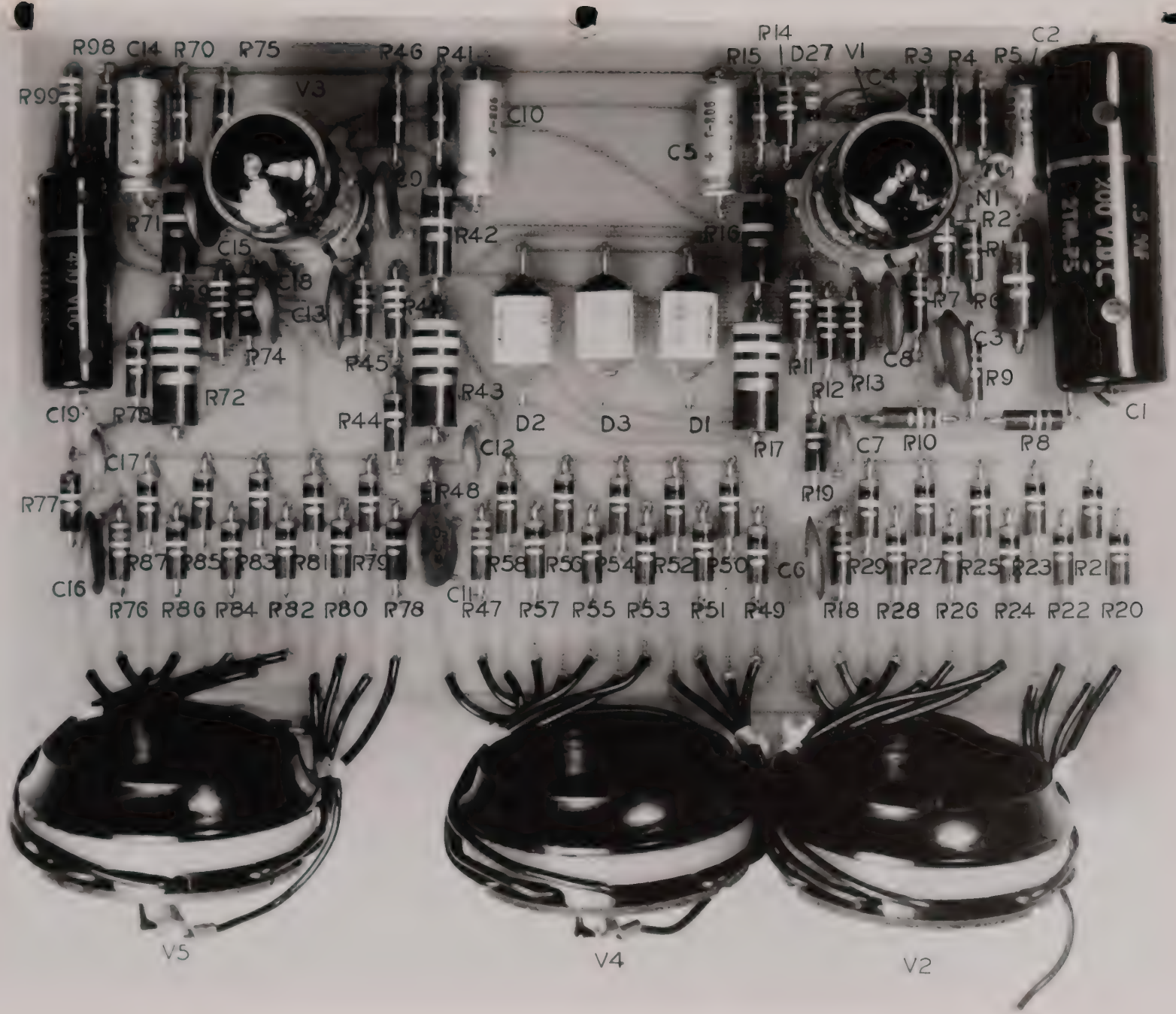
C-34
T-4
T-3
V-8
V-9
T-2
T-1


R98 C14 R70 R75 R46 R41
R99
V3
C10
C5
R71
C15
R42
C18
C13
R74
R45
R43
R44
C19
R78
R72
D2
D3
D1
C12
C17
R48
R77
R87 R85 R83 R81 R79
R58 R56 R54 R52 R50
C16
C11
R76 R86 R84 R82 R80 R78
R47 R57 R55 R53 R51 R49
R14
R15
D27
V1
C4
R3
R4
R5
C2
N1
R2
R1
R16
R7
R6
C3
R11
C8
R9
R12
R13
C1
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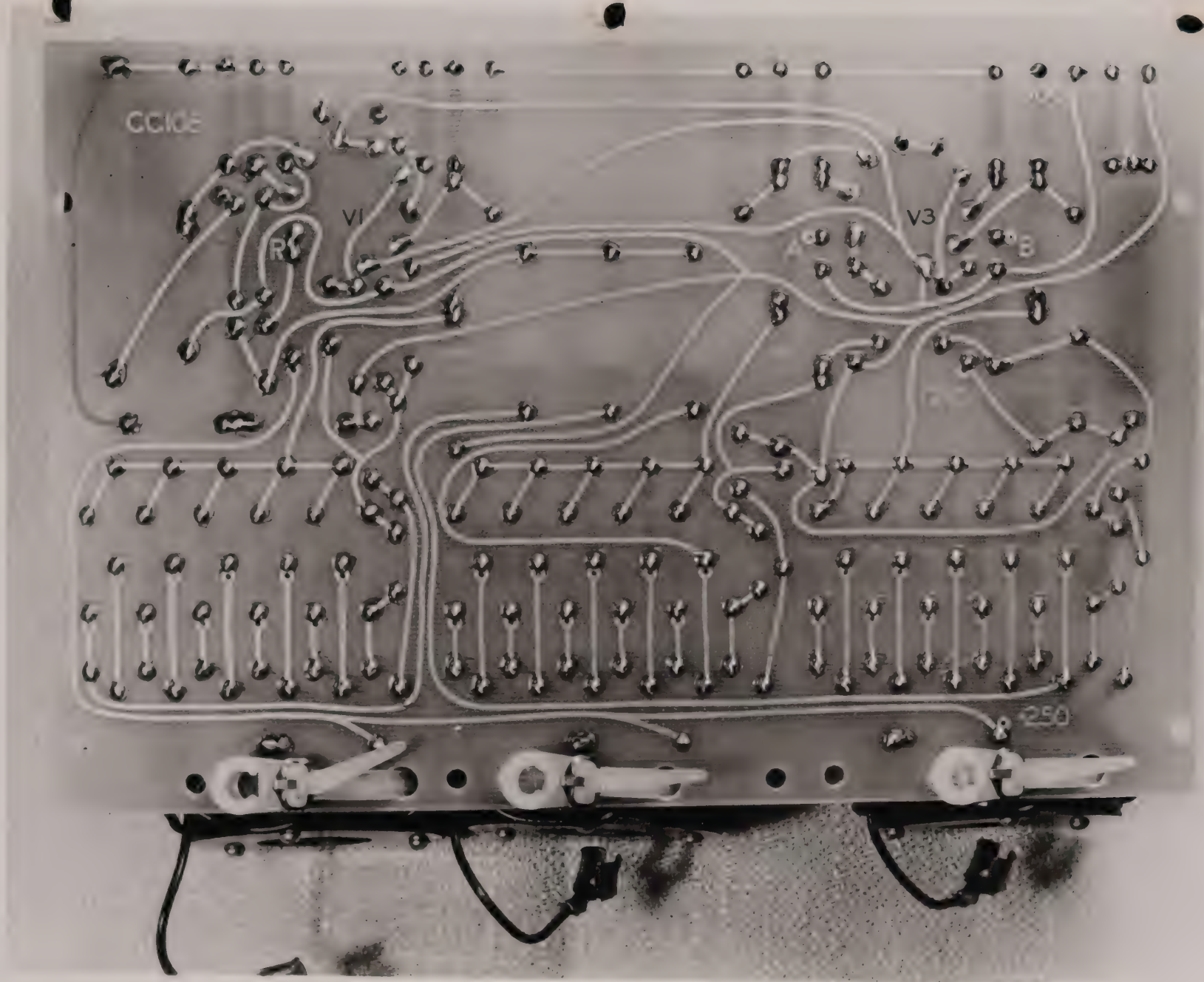
V5
V4
V2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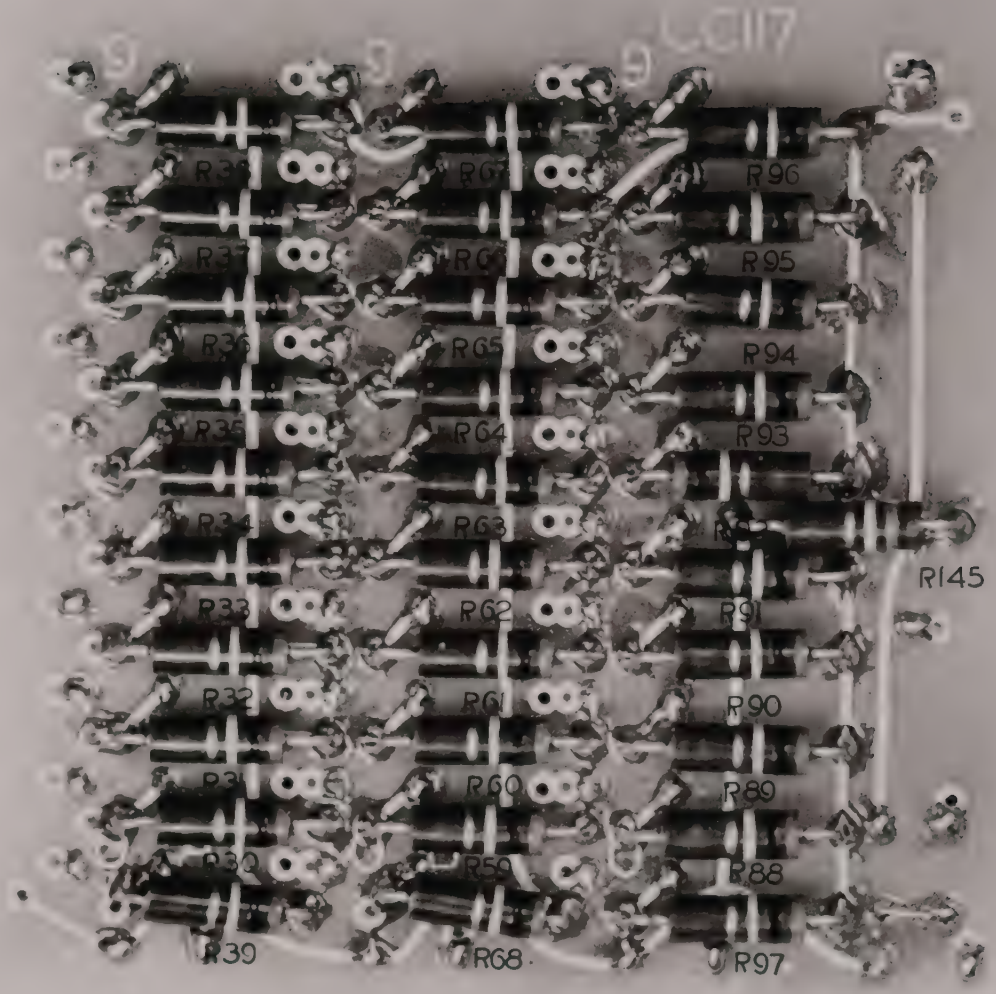
V3
R
A
B
+250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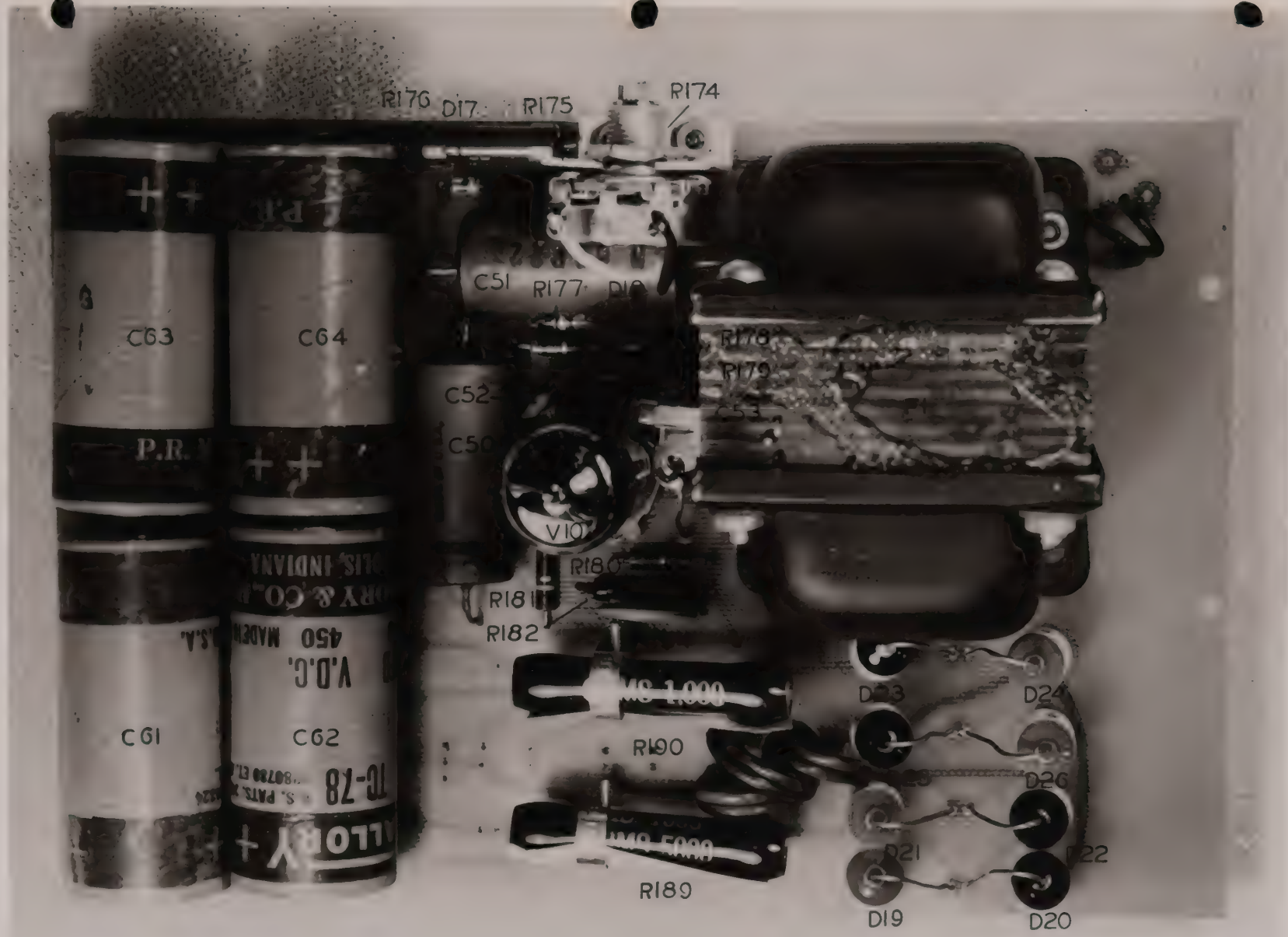
R95
R94
R93
R145
R90
R89
R88
R39
R68
R97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D17
R175
R174
C51
R177
D18
C63
C64
R178
R179
C52
C50
V10
R180
R181
R182
C61
C62
R190
D23
D24
D26
D21
D22
R189
D19
D20

PARTS LIST AND DESCRIPTION

Resistors

Item No.	-	Description
R1	-	10 meg.
R2	-	220K
R3	-	110K
R4	-	1 meg.
R5	-	2K
R6	-	150K 1 watt 5%
R7	-	68K
R8	-	270K
R9	-	27K
R10	-	470K
R11	-	39K
R12	-	100K
R13	-	68K
R14	-	68K
R15	-	1.5K
R16	-	10K 1 watt 5%
R17	-	43K 2 watt 5%
R18	-	68K
R19	-	22K
R20 Thru R39	-	100K
R40	-	39K
R41	-	1.5K
R42	-	10K 1 watt 5%
R43	-	43K 2 watt 5%
R44	-	100K
R45	-	68K
R46	-	1 meg.
R47	-	68K
R48	-	22K
R49 Thru R68	-	100K
R69	-	47K
R70	-	1.5K
R71	-	10K 1 watt 5%
R72	-	43K 2 watt 5%

Item No.	-	Description
R73	-	100K
R74	-	68K
R75	-	1 meg.
R76	-	68K
R77	-	22K
R78 Thru R97	-	100K
R98	-	15K
R99	-	470K
R100	-	620K
R101	-	620K
R102	-	620K
R103	-	68K
R104	-	18K
R105	-	10K
R106	-	120K
R107	-	10 meg.
R108	-	68K
R109	-	33K
R110	-	33K
R111	-	270K
R112	-	33K
R113	-	4.7K
R114	-	1 meg.
R115	-	47K
R116	-	4.7K
R117	-	33K
R118	-	330 Ohm
R119	-	47K
R120	-	10K
R121	-	100K
R122	-	100K
R123	-	100K
R124	-	6.8K
R125	-	2.7K
R126	-	1 meg.
R127	-	47K 2 watt 5%

DATA SHEET

Resistors (Cont.)

Item No.	Description
R128	1.5K
R129	100K
R130	22K
R131	100K
R132	39K
R133	270K
R134	100K
R135	1 meg.
R136	330 Ohm
R137	22K
R138	22K
R139	1 meg. ½W, 5%
R140	330 Ohm
R141	22K
R142	1 meg.
R143	270K
R144	22K
R145	270K
R146	15K
R147	15K
R148	56K
R149	56K
R150	150K
R151	100K
R152	220K
R153	1 meg.
R154	470K
R155	10K
R156	10 meg. 1%
R157	1 meg. 1%
R158	1K
R159	100K
R160	39K
R161	
R162	22K
R163	150K
R164	150K ½W, 5%
R165	1.5K ½W, 5%
R166	1 meg. ½W, 5%
R167	150K
R168	150K ½W, 5%
R169	470 Ohm
R170	75K 2 watt 5%
R171	3.9K
R172	1 meg. Pot
R173	3.9K
R174	100K Pot
R175	400K ½W, 1%
R176	9 meg. 1%
R177	470 Ohm
R178	10K
R179	1 meg.
R180	680 Ohm
R181	15K
R182	1 meg. 1%
R183	287K 1%
R184	100K 1%
R185	9.1K 1%
R186	2 meg. 1%
R187	7 meg. 1%
R188	270K
R189	Ohmite
Dividohm	56K 10 watt
R190	27K 1 watt
R191	32.4K 1%
R192	102 K 1%
R193	1.5 meg. ½W, 5%
R194	100 ohm ½W, 5%

NOTE:

All resistors ½ watt 5%
unless otherwise indicated.

PARTS LIST AND DESCRIPTION

Capacitors

Item No.	-	Description
C1	-	Sprague 200v .5
C2	-	Sprague Electrolytic 6 mf. 25v
C3	-	Erie .01 mf. Disc.
C4	-	Erie .01 mf. Disc.
C5	-	Sprague Electrolytic 6 mf. 25v
C6	-	Erie 500 mmf. Disc.
C7	-	Erie 1500 mmf. Disc.
C8	-	Erie .005 Disc.
C9	-	Erie 470 mmf. Disc.
C10	-	Sprague Electrolytic 6 mf. 25v
C11	-	Erie 500 mmf. Disc.
C12	-	Erie 1500 mmf. Disc.
C13	-	Erie .005 mf. Disc.
C14	-	Sprague Electrolytic 6 mf. 25v
C15	-	Erie 470 mmf. Disc.
C16	-	Erie 500 mmf. Disc.
C17	-	Erie 1500 mmf. Disc.
C18	-	Erie .005 mf. Disc.
C19	-	Sprague .05 mf. 400v
C20	-	Erie 470 mmf. Disc.
C21	-	Erie .001 mf. Disc.
C22	-	Erie 470 mmf. Disc.
C23	-	Erie .01 mf. Disc.
C24	-	Erie .01 mf. Disc.
C25	-	Erie .01 Disc.
C26	-	Sprague Electrolytic 25 mf. 50v
C27	-	Erie .01 mf. Disc.
C28	-	Erie .01 mf. Disc.
C29	-	Erie 500 mmf. Disc.
C30	-	Erie .01 mf. Disc.
C31	-	Sprague .05 mf. 400v
C32	-	El Menco Trimmer #469
C33	-	El Menco Trimmer #469
C34	-	El Menco Trimmer #469
C35	-	Sprague .002 mf. 600v
C36	-	Erie .01 mf. Disc.
C37	-	Erie .01 mf. Disc.

Capacitors (Cont.)

Item No.	-	Description
C38	-	1 mf. 200v
C39	-	Erie .04 mf. Disc.
C40	-	Erie 1500 mmf. Disc.
C41	-	Erie 500 mmf. Disc.
C42	-	Erie .01 mf. Disc.
C43	-	Erie .001 mf. Disc.
C44	-	Sprague Electrolytic 25 mf. 50v
C45	-	Erie .005 mf. Disc.
C46	-	Sprague Electrolytic 30 mf. 6v
C47	-	Erie 250 mmf. Disc.
C48	-	Sprague Electrolytic 60 mf. 6v
C49	-	Erie .01 mf. Disc.
C50	-	Sprague .15 mf. 200v
C51	-	Sprague .15 mf. 200v
C52	-	Erie .01 mf. Disc.
C53	-	El Menco Trimmer #460
C54	-	Centralab .1 mf. Disc.
C55	-	El Menco Trimmer #460
C56	-	El Menco Trimmer #460
C57	-	El Menco Trimmer #460
C59	-	Arco El Menco Dur-Mica 500 mmf.
C60	-	Sprague .002 mf. 600v
C61	-	250 mmfd. Disc.

Thru Mallory Electrolytic 40 mf. 450v
C64

PARTS LIST AND DESCRIPTION

Diodes

Item No.	-	Description
D1	-	
Thru	-	Hoffman HB-6
D3	-	
D4	-	
Thru	-	H-B6 Hoffman Diode
D8	-	
D9	-	
Thru	-	HB-1
D14	-	
D15	-	Pacific Semiconductor 1N789
D16	-	Pacific Semiconductor 1N789
D17	-	Radio Receptor HB-6
D18	-	Radio Receptor HB-6
D19	-	
Thru	-	Sarkes Tarzian K-200
D26	-	
D27	-	Radio Receptor 1N34
D28	-	Hoffman 1N468

Tubes

Item No.	-	Description
V1	-	12AT7
V2	-	Mullard Z502S
V3	-	12AT7
V4	-	Mullard Z502S
V5	-	Mullard Z502S
V6	-	12AT7
V7	-	12AT7
V8	-	6CBC Electron Tube
V9	-	6CBC Electron Tube
V10	-	12AT7

Miscellaneous

Item No.	-	Description
N1	-	
Thru	-	G. E. Neon Lamp NE-2E
N49	-	
K1	-	Minarik Elec. Co. Fan #DB 11029

TRANSISTORS

Item No.	-	Description
T1	-	Raytheon 2N363
T2	-	Raytheon 2N363
T3	-	Raytheon 2N363
T4	-	Raytheon 2N363
T5	-	Raytheon 2N327A
T6	-	Raytheon 2N619
T7	-	Raytheon 2N327A

TRANSFORMERS

Item No.	-	Description
F1	-	Triad (Power) special #67066
F2	-	Thordarson TR-14

BATTERY

Item No.	-	Description
B2	-	Mallory Mercury Battery RM-1RT2

SWITCHES

Item No.	-	Description
S2	-	Centralab Rotary Switch PA-2031
S3	-	Centralab Rotary Switch PA-2031
S1	-	Carling Switch #2FA53-73

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